



**UNIVERSITI PUTRA MALAYSIA**

**BIOCOMPATIBILITY BETWEEN FLORA AND FAUNA UNDER  
SIMULATED OUTDOOR AND INDOOR BIOPARK**

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**FP 2000 26**

**BIOCOMPATIBILITY BETWEEN FLORA AND FAUNA UNDER  
SIMULATED OUTDOOR AND INDOOR BIOPARK**

**By**

**MAKE JIWAN**

**Thesis Submitted in Fulfilment of the Requirements for the Degree of Master  
of Science in the Faculty of Agriculture  
Universiti Putra Malaysia**

**August 2000**



To God, Mom, Dad, brothers and sisters, lovely daughter Ellwylnea Dorantez,  
beloved wife, and to all the animals and flowers that have enriched my life



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in  
fulfilment of the requirements for the degree of Master of Science.

**BIOCOMPATIBILITY BETWEEN FLORA AND FAUNA UNDER  
SIMULATED OUTDOOR AND INDOOR BIOPARK**

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**Chairman: Professor Dr. Dahlan Ismail**

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The biocompatibility between flora and fauna in BioPark was evaluated. A group of 20 heads of *Cervus timorensis* (Timorensis), 5 heads respectively of *Axis axis* (Axis), *Cervus unicolor brookei* (Sambar) and *Muntiacus atherodes* (Muntjac) were studied in Outdoor BioPark. In Indoor BioPark, 16 heads of *Callosciurus prevostii borneansis* (Prevost's squirrel), 10 heads of *Tragulus javanicus* (Kancil) and 6 heads of *Tragulus napo* (Pelandok) were used for the purpose of study. In Outdoor BioPark, the biocompatibility between the deer species with *Acacia mangium* and its natural vegetation were studied. Meanwhile in Indoor BioPark, introduced flora species were used.

The study found that the undergrowth vegetation of *A. mangium* plantation was biocompatible with the tested deer species. With monthly forage yield of

183.28 kg (DM) per ha or 1392.93 MJ ME per ha with 75% total available forage grazed, the *A. mangium* undergrowth could be stocked with 5 to 9 heads of Muntjac, or 1 to 3 heads of Timorensis, or 2 to 7 heads of Axis, or 1 to 2 heads of Sambar deer. Based on captive feeding habit and requirements of the Mousedeer species, the area also could be stocked with Kancil and Pelandok with allowable carrying capacity of 18 to 42 heads of Pelandok and 44 to 132 heads of Kancil, respectively.

It was found that some of the deer was not biocompatible with *A. mangium* stands. Of all the deer species tested, it was found that only Sambar and Muntjac were biocompatible and did not cause any significant debarking damage on the matured stands of *A. mangium*. Biocompatibility between deer species and *A. mangium* was influenced by tree bark architecture (bark surface coarseness) and taxonomy (thickness), deer species, number of individual stags stocked and the animal's feed management.

The biocompatibility between Prevost's squirrel, Pelandok and Kancil with introduced flora in Indoor BioPark had found that feed factor in terms of quantity and availability together with the availability of juvenile individuals were the most associated factors with the animal's herbivory. Other factors were includes the animal's stocking rate and plant's species used.

Understanding of the factors associated with the animals herbivory could help in the development and management of an ecologically balanced and healthier BioPark ecosystem. BioPark management measures in relation to flora-fauna biocompatibility were fully discussed through out the study. Healthier and ecologically balanced BioPark not only contributed to the fauna and flora well-being but also to the satisfaction of visitors and their better understanding towards conservation. This study concluded that the biocompatibility between flora and fauna was influenced by many manageable factors.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

**BIOKESERASIAN ANTARA FLORA DAN FAUNA DI DALAM BIOPARK  
LUARAN DAN DALAMAN YANG DISIMULASIKAN**

**Oleh**

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Biokeserasian antara flora dan fauna dalam BioPark telah dikaji. Kumpulan yang terdiri daripada 20 ekor *Cervus timorensis* (Timorensis), 5 ekor *Axis axis* (Axis), 5 ekor *Cervus unicolor brookei* (Sambar) dan 5 ekor *Muntiacus atherodes* (Kijang) telah dikaji di dalam BioPark Luaran. Dalam BioPark Dalaman, 16 ekor *Callosciurus prevostii borneansis* (Tupai Gading), 10 ekor *Tragulus javanicus* (Kancil) dan 6 ekor *Tragulus napo* (Pelandok) telah digunakan untuk tujuan kajian. Dalam Outdoor BioPark, biokeserasian antara spesies rusa dengan *Acacia mangium* dan tumbuhan semulajadinya telah dikaji. Dalam pada itu, dalam BioPark Dalaman, flora yang digunakan adalah kesemuanya terdiri daripada spesis yang diperkenalkan.

Kajian mendapati bahawa tumbuhan bawah yang terdapat di kawasan penanaman *A. mangium* adalah bersifat bioserasi dengan spesies rusa yang dikaji. Dengan pengeluaran foraj bulanan sebanyak 183.28 kg (berat kering) ataupun 1392.93 MJ ME per ha dengan 75% jumlah foraj digunakan, tumbuhan bawah *A. mangium* boleh menampung sebanyak 5 ke 9 ekor Kijang, atau 1 ke 3 ekor rusa Timorensis, atau 2 ke 7 ekor rusa Axis atau 1 ke 2 ekor rusa Sambar. Berdasarkan kajian sifat pemakanan dan keperluan dalam sangkar, kawasan ini juga dapat membekalkan makanan kepada Kancil dan Pelandok dengan jumlah penstokan antara 18 ke 42 ekor Pelandok dan 44 ke 132 ekor Kancil, masing-masingnya.

Didapati bahawa ada antara spesies rusa berkenaan tidak bioserasi dengan pokok *A. mangium*. Dari kesemua spesies rusa yang dikaji, didapati cuma Sambar dan Kijang yang bersifat bioserasi dan tidak menyebabkan kerosakan pembuangan kulit yang bererti terhadap pokok *A. mangium*. Biokeserasian antara rusa dengan *A. mangium* adalah dipengaruhi oleh sifat arkitek (kekasaran permukaan) dan taksonomi kulit pokok (ketebalan), spesies rusa, bilangan individu rusa jantan distok dan pengurusan permakanan haiwan berkenaan.

Biokeserasian antara *C. prevostii borneansis*, *T. napo* dan *T. javanicus* dengan flora yang diperkenalkan dalam Indoor BioPark, adalah didapati bahawa faktor pemakanan dari segi kuantiti dan kedapatan dan kedapatan individu juvenil



adalah faktor yang paling berkaitan dengan tingkahlaku pemakanan haiwan berkenaan. Faktor lain yang dikenalpasti termasuk kadar penstockan dan spesies tumbuhan yang digunakan.

Pemahaman faktor yang berkaitan dengan pemakanan haiwan dapat membantu dalam pembangunan dan pengurusan BioPark supaya berada dalam keadaan kestabilan ekologi dan persekitaran BioPark yang sihat. Langkah-langkah pengurusan BioPark dari segi biokeserasian flora dan fauna dibincangkan dengan terperinci dalam kajian ini. Keadaan ekosistem BioPark yang sihat dan stabil dari segi ekologinya bukan sahaja menyumbang kepada pembentukan dan kebajikan haiwan tetapi juga untuk kepuasan pengunjung dan memudahkan pemahaman mereka terhadap konservasi. Kajian ini menyimpulkan bahawa, biokeserasian antara flora dan fauna adalah dipengaruhi oleh faktor yang boleh-urus.

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I certify that an Examination Committee met on 1<sup>st</sup> August 2000 to conduct the final examination of Make Anak Jiwan on his Master Science thesis entitled "Biocompatibility between Flora and Fauna under Simulated Outdoor and Indoor BioPark" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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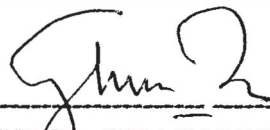
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I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

  
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## TABLE OF CONTENTS

	<b>Page</b>
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	vi
ACKNOWLEDGMENTS	ix
APPROVAL SHEETS	x
DECLARATION FORM	xii
LIST OF TABLES	xvi
LIST OF FIGURES	xviii
GLOSSARY OF ABBREVIATIONS	xx
<b>CHAPTER</b>	
<b>1 INTRODUCTION</b>	<b>1</b>
1 1 Justification	4
1 2 Objectives	5
<b>2 LITERATURE REVIEW</b>	<b>6</b>
2 1 What is BioPark?	6
2 2 Plants-Herbivore Biocompatibility	8
2 2 1 Adaptations of Plants to Mammalian Herbivores	9
2 2 2 Adaptations of Mammalian Herbivores to Plants	11
2 3 Effects of Herbivory	17
2 4 Carrying Capacity	20
<b>3 GENERAL METHODOLOGY</b>	<b>24</b>
3 1 Site Description	24
3 1 1 Outdoor BioPark	24
3 1 2 Indoor BioPark	26
3 2 History of Animal's Used and Selection Criteria	27
3 3 Animals Feed Management	28
3 3 1 Mousedeer (Kancil and Pelandok)	29
3 3 2 Prevost's Squirrel	30
3 3 3 Muntjac	30
3 3 4 Deer (Sambar, Timorensis and Axis)	31
3 4 Plant Selection In Relation to Indoor BioPark Study	32

4	<b>DEER-FLORA BIOCOMPATIBILITY IN OUTDOOR BIOPARK</b>	34
4.1	Introduction	34
4.2	Methodology	36
4.2.1	Floristic Study of Outdoor BioPark	36
4.2.2	Deer Preference Test	39
4.2.3	Forage Intake	42
4.2.4	Debarking Damage	43
4.3	Browsing and Debarking Damage Assessment	46
4.4	Data Classification and Analysis	51
4.5	Result	53
4.5.1	Floristic Composition of <i>Acacia mangium</i> Plantation	53
4.5.2	Deer Preference Test	69
4.5.3	Forage Intake	81
4.5.4	Deer Debarking Damage	82
4.6	Discussion	98
4.6.1	Forage Composition and Quality	98
4.6.2	Forage Utilisation and Forest Carrying Capacity	103
4.6.3	Deer Herbivory and It's Impact on <i>Acacia mangium</i> Plantation and Factors Associated	109
4.7	Conclusion	118
5	<b>PLANTS-ANIMALS BIOCOMPATIBILITY IN INDOOR BIOPARK</b>	119
5.1	Introduction	119
5.2	Methodology	121
5.2.1	Effect of Prevost's Squirrel and Pelandok Densities on Plant Damage	121
5.2.2	Effect of Feed Quantity on Plant Damage	124
5.3	Plant Arrangement	126
5.4	Damage Assessment	128
5.5	Data Analysis	129
5.6	Result	130
5.6.1	Plant Damage in Relation to Animal Densities	130
5.6.2	Plant Damage in Relation to Diet Quantity	135
5.7	Discussion	139
5.7.1	Squirrel Herbivory Damage	139
5.7.2	Mousedeer Herbivory Damage	143
5.8	Conclusion	146

<b>6</b>	<b>GENERAL DISCUSSION AND CONCLUSION .....</b>	<b>147</b>
6.1	Biocompatibility of BioPark's Flora-Fauna and Management Implications .....	147
6.1.1	Outdoor BioPark's Deer-Fauna Biocompatibility .....	147
6.1.2	Indoor BioPark's Flora-Fauna Biocompatibility .....	156
6.2	Habitat Improvement for BioPark .....	167
6.2.1	Outdoor BioPark (Acacia Forest Plantation) .....	167
6.2.2	Indoor BioPark Habitat Enhancement .....	176
6.3	Designing For Herbivore Resistance: Combining Flora with Fauna .....	178
6.4	Conclusion .....	184
	<b>REFERENCES .....</b>	<b>186</b>
	<b>APPENDICES .....</b>	<b>205</b>
	<b>BIODATA OF AUTHOR .....</b>	<b>228</b>



## LIST OF TABLES

Table	Page
1 Types and quantity of diets given for two different Mousedeer species .....	34
2 Types and quantity of diets given to Muntjac .....	35
3 Types and quantity of diets given to each deer species .....	36
4 Lists of flora selected and used .....	37
5 Bark thickness of surveyed trees and shrubs .....	59
6 Common undergrowth species in <i>A. mangium</i> plantations and their nutritive values .....	61
7 Compositional differences between <i>A. mangium</i> leaves and pods .....	62
8 Total available edible forage biomass (dry matter basis) and metabolisable energy (ME) in each paddock .....	63
9 Total biomass and metabolisable energy of different edible forage per hectare under <i>A. mangium</i> plantation .....	64
10 Monthly Dry Matter Yield (MDMY) of undergrowth forage at five cuttings interval .....	68
11 Average time (minutes) spent on each forage species over six paddocks .....	69
12 Selective Index, Biological Index and Preference Index of herbage found under <i>A. mangium</i> plantation.....	70
13 Types and frequency of damage occurred during the 1 <sup>st</sup> day until the 7 <sup>th</sup> day of releasing on six different paddocks .....	72
14 Browsing and debarking preference of Timorensis deer .....	73
15 Effect of bark thickness on debarking .....	79
16 Mean daily forage intake by free ranging Timorensis according to their biomass .....	81
17 Mean Stem Debarked at GBH (SGBH) and Damage Severity Index (DSI) inflicted by different deer species on different tree species .....	86
18 Total trees debarked and Damage Severity Index (DSI) caused by Muntjac on different plant species .....	88
19 Different on total trees debarked by all deer species .....	90
20 Qualitative description of debarking damage performed by each deer species on each tree species .....	92
21 Types of damage caused by three deer species on <i>A. mangium</i> stems .....	93
22 Debarking lethality on major tree species .....	96
23 Ecological carrying capacity of <i>A. mangium</i> forest per hectare .....	106

24	Mean Plant Biomass Removed (PBR) and Damage Severity Index (DSI) inflicted by Prevost's squirrel on different plant species .....	131
25	Plant Biomass Removed (PBR) and Damage Severity Index (DSI) inflicted by different plant species by juveniles and adult squirrels ....	132
26	Effect of Pelandok densities on Plant Biomass Removed (PBR) and damage severity index (DSI) .....	134
27	Effect of diet quantity on different plant species damage caused by Prevost's squirrel .....	135
28	Effect of feed abundance on Plant Biomass Removed (PBR) and Damage Severity Index (DSI) by Kancil on different plant species . ..	136
29	Effect of feed abundance on Plant Biomass Removed (PBR) and Damage Severity Index (DSI) of tested plants caused by Pelandok ...	137
30	Lists of poisonous ornamental plants .....	171
31	Feed intake of Pelandok .....	212
32	Feed intake of Kancil .....	212
33	Feed intake of Prevost's squirrel .....	213
34	Dry matter feed intake of Muntjac .....	213
35	Dry matter feed intake of free ranging Timorensis, Sambar and Axis deer .....	213
36	Nutritional value of diet given to Mousedeer .....	214
37	Nutritional contents of banana and papaya fed to Prevost's squirrel ..	214
38	Chemical and nutritional contents of deer's diets .....	214
39	Successful combination of BioPark's animals .....	215
40	Unsuccessful combinations in BioPark .....	216
41	Causes of Mousedeer mortality in Indoor BioPark .....	219
42	Breeding performance of Prevost's squirrel (1997-1999) .....	220
43	Statistical information about Prevost's squirrel .....	220
44	Fawning and rearing success of deer .....	220
45	Enclosure size for handling BioPark's animals .....	224
46	A list of food plants for Muntjac, deer, Mousedeer and squirrels .....	225
47	BioPark roles of naturally available vegetation in <i>A. mangium</i> plantation .....	226
48	List of fruit and seeds bearer plants for Outdoor BioPark's animals ...	227

## LIST OF FIGURES

Figure		Page
1	Plant arrangement in relation to Muntjac .....	49
2	Debarking damage assessment method .....	50
3	Distribution and abundance of large shrubs and trees ( $\geq 5$ cm GBH) in each paddock .....	54
4	Distribution and abundance of small trees and shrubs (4.5 cm $\geq$ GBH $\geq$ 1 cm) in each paddock .....	55
5	Distribution and abundance of undergrowth forage species in each paddock .....	57
6	Undergrowth forage plant available in two different paddock .....	58
7	Bark architecture of three different tree species, (A) <i>A. mangium</i> , (B) <i>C. zeylanicum</i> and (C) <i>M. paniculatus</i> .....	60
8	Forage biomass in each paddock in relation to tree stocking density .....	66
9	Perspective view of vegetation under high standing tree stocking density and under low standing tree stocking density .....	67
10	Timorensis deer browsing preference .....	75
11	Defoliation of <i>Musa</i> spp., <i>Calamus</i> spp. and <i>E. guineensis</i> by Timorensis deer .....	76
12	Timorensis debarking preference .....	77
13	Effect of bark architecture on Timorensis debarking preference .....	80
14	Debarking performance of two different Timorensis ages .....	84
15	Condition in two different paddocks between yearling and adult .....	85
16	Muntjac browsing and debarking damage on <i>Dillenia</i> spp., <i>F. elastica</i> , <i>F. benjamina</i> and <i>Dillenia</i> shoots .....	89
17	Comparison of paddock and <i>A. mangium</i> stands condition between Axis, Timorensis and Sambar .....	91
18	Types of debarking performed by Timorensis, Axis and Sambar deer on <i>A. mangium</i> trees .....	95
19	Plant arrangement in Indoor BioPark .....	127
20	Prevost's squirrel herbivory damage on <i>T. flumimensis</i> , <i>Helicornia</i> spp., <i>C. lutescens</i> and <i>A. nidus</i> .....	133
21	Pelandok herbivory on <i>P. ensiformis</i> , <i>N. exalta</i> and <i>T. flumimensis</i> .....	138
22	Paddock and vegetation plan of Outdoor BioPark .....	206
23	Picture of animals available in Outdoor BioPark .....	207
24	Detail drawing of Mousedeer exhibit in Outdoor BioPark .....	208
25	Perspective view of facilities provided in Outdoor BioPark .....	209
26	Floor plan and facilities provided in Indoor BioPark .....	210

27	Birth pattern of Kancil colony in BioPark since 1997-1999 .....	217
28	Monthly mortality rate of Kancil in BioPark .....	218
29	Picture of BioPark's animals offspring .....	221
30	Differences between common Muntjac and Yellow Muntjac .....	222
31	Colour variation between two Sambar's fawns .....	223

## GLOSSARY OF ABBREVIATIONS

Most abbreviations used in this thesis are preceded on first mention by the full name. However, those more frequently repeated are listed below for easy reference.

DBH	diameter at breast height
GBH	girth at breast height
SGBH	stem debarked at GBH
CP	crude protein
EE	ether extracts
ADF	acid detergent fibre
NDF	neutral detergent fibre
GE	gross energy
ME	metabolisable energy
DMD	dry matter digestible
DSI	damage severity index
DA	debarked area
MDMY	monthly dry matter yield
DM	dry matter
MJ	Mega Joule
DMI	dry matter intake
PBR	percentage of plant biomass removed
PL	biomass lost
Ai	percentage availability
U <sub>i</sub> <sub>bro</sub>	percentage utilisation for browsing damage
U <sub>i</sub> <sub>deb</sub>	percentage utilisation for debarking damage
Pr <sub>browse</sub>	preference ratio for browsing damage
Pr <sub>debark</sub>	preference ratio for debarking damage
SAS	Statistical Analysis System
DMRT	Duncan Multiple Range Test
CRD	Completely Randomised Design
ANOVA	Analysis of variance
SD	Standard deviation

## **CHAPTER 1**

### **INTRODUCTION**

In these modern days of the industrialisation and urbanisation process, destruction of natural habitat through logging, agricultural, housing and industrialisation activities had caused conflict on land use. Utilisation of the available forest resources, idle mining and agricultural lands through plant-animal integration will reduce the conflict besides conserving and improving the natural habitat and landscape. Besides conflict on land use, we also face the conflict on the way we have exhibited and educated the public about the importance of flora and fauna. The possible factors that contributed to this phenomenon was most possibly on the way we had managed and utilised our natural resources such as wildlife and forest resources.

Previously we had exhibited the wildlife in zoological park and flora in botanical garden but the availability of these natural resources in their natural habitat, do not give better economic and educational importance to the country and the public except in national parks, forest parks, or wildlife sanctuaries. Therefore, in order to optimise the utilisation of the natural resources sustainable and to help the public to better understand the importance of both fauna and flora, the application of BioPark concept could fulfil these necessities. According to Gould (1991) the existence of BioPark was due to the recognition of the inseparable relationship between flora,

fauna and humans. The concept of BioPark is to generate the habitat of the appropriate animal by using suitable plants and consideration of other physical and physiological needs of the animals or plants. Dahlan (1998) noted that BioPark elements should exist in a non-barrier area of a balance ecosystem and foremost , Page (1990) noted that the BioPark was a place to tell the story of our evolutionary, ancestry, and the growth of human culture, arts, and artefacts.

The theory and principle of BioPark is to portray life in all their interconnectedness within one bio-exhibit in an ecologically balanced ecosystems. BioPark is not confined to wildlife conservation, recreational, entertainment and education but the concept also can be used in livestock production to give better return to the investor (Dahlan, 1998). The increasing demands for outdoor recreation activities, the availability of BioPark in the urban and suburban areas with beautiful landscape and facilities could fulfil the need. Thus, BioPark is a new idea in utilisation of natural resources of flora and fauna (domesticated or wildlife).

BioPark can be categorised into indoor and outdoor. Almost all the elements for outdoor and indoor BioPark are the same except that indoor BioPark is developed within a building compound. Meanwhile, outdoor BioPark develops in a limited area of a natural ecosystem. Each BioPark has their owns characteristics. Some BioPark developed as single species, and some as multi-species parks. For example, Kuala Lumpur Lake Garden is considered as one multi species BioPark as a whole but the

animals were displayed as mono-species which include Mousedeer Garden, Butterfly Garden and Deer Garden (Fallow deer). Meanwhile, the best example for multi species BioPark is Parliament Garden, which contained various species of deer (Sambar, Timorensis and Chital deer). The aim of BioPark is to promote good animal welfare, genetic diversity and educating the public about animal behaviour and habitat through the simulation of the natural habitat of animals as well as allowing the animals to display of more natural behaviour (Ford and Stroud, 1993).

In general, vegetation, soil, air, macro and micro fauna form our environment.. But of all these, vegetation plays a major role in stabilising the structural configuration of nature. Therefore flora is the most important component in BioPark. Vegetation aided the creation of habitat that sustain and enhances BioPark. Therefore, the selection of plant must suit the habitat as well as the animals and human requirements in the BioPark. The environment of the BioPark must look natural and closely resembles the animal natural habitat. Through the integration of indoor and outdoor BioPark, it will be a place for education, inspiration, amusement, entertainment and healing of some diseases (neuro-phsycotherapy). This contextual approach not only allows for cognitive learning but also encourages effective learning about the animals and plants. Somehow, the success of the application of the BioPark concepts is depending on the understanding of the factors involved.



Without fauna the landscape of the BioPark will not become alive and attractive. Dahlan and Nik Marzuki (1996) noted that small herbivores and pheasants together with exotic and wildlife species were most preferred compared to carnivores, omnivores, reptiles and large mammals. Herbivores like Cervidae and Tragulidae and small mammals like shrews, squirrels and non-predator animals are also suitable. The choice of plants and animals for a BioPark should be based on characteristics of the site and indigenous species. Local or native species of flora and fauna should be the first priority. Fauna species introduced to the BioPark can be monospecies or multispecies combinations (Dahlan, 1998). The flora and fauna used should create a balance landscape that is sustainable. To create such a landscape, biocompatibility issues between flora and fauna need to be considered.

### **1.1 Justification**

The close proximity between flora and fauna in a confined environment often resulted in damage to the flora. The damage is often severe between herbivorous animals and plants that are susceptible and palatable. However, toxic and unpalatable plants will be spared. Nevertheless, their presence might be a threat to these animals as accidental ingestion can lead to animal fatality (Knight and Dorman, 1997). Thus, the relationship between herbivorous animal and plants should be look from both aspects i.e. the impact of animals on plants in relation to their herbivory activities as well as the impact of plants on animals. This is essential because plant is not only